Panel 3 Introduction

Technology Research, Development, and Evaluation

Papers in this panel focus on concepts for improving energy efficiency through both new technologies and improved design practices applied to existing technologies. The papers cover issues related to appliances, lighting, office equipment, building envelope, and commercial cooling equipment.

Overview Papers

The overview session covers two topics—integrated envelope and lighting systems and cool storage technologies—both for commercial buildings. Lee, Selkowitz, Rubinstein, Klems, Beltrán, and DiBartolomeo show how an integrated systems approach to designing building envelope and electric lighting components can result in both improved occupant comfort and higher energy savings. Results are given for several cases to demonstrate their effectiveness. Braun presents an overview of commercial building and storage technologies that describes the different system types available and discusses advantages and disadvantages of each in various applications. These overviews provide excellent state-of-the-art information on commercial lighting and cooling technologies.

Refrigerators

Papers in this section describe new developments in domestic refrigerators that can result in significant energy savings and less impact upon the environment. Feist, Farhang, Erickson, Stergakos, Brodie, and Liepe describe the goals, processes, and results of the Super Efficient Refrigerator Program that was designed to accelerate commercialization of CFC-free, highly efficient refrigerators. The super-efficient refrigerator should achieve energy savings that exceed 1993 federal standards by 25 to 50 percent and will be free of CFC materials. The paper describes aspects of the program that could form a foundation for other national programs. In a complementary paper, Briskin and Fine describe a joint Sine-US project to develop and manufacture a CFC-free super-efficient refrigerator for China, Energy savings of up to 70 percent over current refrigerators are estimated. The paper presents preliminary test results and describes the next stages in this project. Bourne reports on the design and testing of a combined refrigerator-water heater for residential applications. The preliminary analyses and tests indicate that this technology can offer significant source energy savings.

Integrated Appliances

Both electric and gas integrated appliances have been tested in single-family, multifamily, and commercial buildings. Torbin and Belkus describe an innovative natural gas piping system that was used with a dual-integrated gas-fired space and water heating system in multifamily buildings. Energy savings based solely on decentralized configurations for each building unit range from 7 to 17 percent. Neal presents the results of the single-family home field test of an integrated electric heat pump and water heater. When installed in a home in Wilmington, North Carolina, the integrated system resulted in an energy savings for the year of 63.6 percent. Another study of the use of dual-integrated (space and water heating) gas-fired systems in multifamily and small commercial buildings is presented by Bohac, Hancock, Dunsworth, and Makredes. This two-year study reported an average energy savings of 11 percent. Units with atmospheric burners reported no system failures, but sealed combustion units had a number of failures in operation.

Lighting in Commercial Buildings

Studies of lighting in commercial buildings covered various aspects of the problem. Sezgen and Huang presented a method for quantifying the impacts of lighting conservation measures on annual and peak HVAC requirements. Lighting reductions tend to increase a building's heating needs and reduce its cooling needs. Quantification of the net change in a building's annual and peak energy use depends on the building characteristics, operating conditions, and climate. In a paper

describing a specific lighting conservation technique, Stiles and McCluney discuss the performance of a passive daylighting system known as SPRA (stationary projecting reflector arrays) in supplanting the use of electric lights. Depending on the control strategy used, the implementation of SPRA daylighting can result in annual lighting energy savings between 25 and 44 percent. The use of a distributed daylighting scheme to control energy use in a Wisconsin office building is described by Reed, Pinkowski, Caldwell, Mapp, White, and Hall. Extensive experimentation has provided information on control system and window treatment system needs.

Commercial Cooling

Papers in this section describe the development and evaluation of technologies for providing cooling that can result in significant energy savings. Kopko and Hibberd report on the design of a high-efficiency rooftop air conditioner whose development and evaluation is funded by the U.S. Environmental Protection Agency and the California Institute of Energy Efficiency. The design calls for the use of readily available components and a 40 percent improvement in efficiency over conventional designs. Puga and Lau describe the field evaluation of indirect evaporative cooling coupled to vapor compression equipment. The paper gives operational experiences, the approach taken to monitor performance, and methods that will be used to communicate results to designers, developers, and users. Nugent also focuses on evaporator cooling as a means of lowering the condenser temperature for vapor compression air conditioning equipment. This paper provides energy-efficient design options and a design methodology for evaporative condensers.

Innovative Heating and Cooling Technologies

This section focuses on some future energy saving technologies for providing heating or cooling. Parker and Dunlop address the feasibility of using photovoltaics to power air conditioning equipment in residential applications. In particular, they describe an approach for optimizing the design of the building, air conditioning system, and photovoltaic array size. Hughes reviews the status of gas-fired heat pumps. In addition to identifying the major players and driving forces for product introductions, this paper reviews the technology status, manufacturer commitments, and product introduction timetables. In a complementary paper, Lutz reviews and evaluates gas-fired heat pump technologies that could be used for residential water heating. Current development status, potential problems, and estimates of performance and manufacturing costs are given for a number of technologies.

Building Envelope

Energy gains or losses through the building envelope can represent a significant portion of a building's total energy requirement. This section presents opportunities for improving the cost effectiveness of building envelopes. Elberling and Bourne demonstrate the potential savings associated with the use of integrated design methods. Two houses were constructed and are being monitored. The buildings were designed to maintain occupant comfort without the use of vapor compression equipment, with a projected reduction in energy use of 60 percent over conventional designs. Kosny investigates the use of walls that are constructed with wood and concrete. Wooden concrete has a low thermal conductivity, is easy to work with, and is virtually nonflammable. This paper presents a comparison of the performance of alternative masonry walls and demonstrates the advantages of wooden concrete.

Efficient Appliances and Office Equipment

Efficient laundry and cooking appliances are discussed in this session, along with efficient office equipment. Pope and Slavin discuss the market barriers to increased use of horizontal axis clothes washers, and the utility incentive programs designed to overcome these barriers. Incentive programs are recommended to acquire this demand-side resource. Lobenstein, Hewett, and Nathan describe the status and future direction for commercial gas cooking appliances. Typical payback periods for these efficient appliances are between five and seven years, which are longer than most commercial customers will accept, and therefore, some other mechanism for moving the market may be necessary. New energy-efficient office equipment is discussed by Smith, Harris, and Blatt, who point out that electricity use by office equipment is the fastest-growing category of commercial building electricity use in the United States. Several mechanisms are described to encourage the use of the new energy-efficient equipment.

Energy Monitoring Methods and Results

End-use monitoring is an important tool in evaluating the impact of new technologies on energy use. This section presents both methods for and results of field monitoring. Mazzucchi gives an overview of the metering technologies that are suitable for the evaluation of demand-side management programs. The opportunities for utilizing energy management and control systems for field monitoring are discussed. Hill, Englander, Judson, and Parece present the results of a monitoring study of electric motors. Over 200 motors were monitored in order to evaluate the potential for energy savings that could result from the use of more efficient motors and variable-speed drives. The results indicate that many installations may benefit from the use of more efficient motor technologies. Palmiter and Francisco present results from heating system efficiency tests on 24 homes. They used the monitored data to select six homes that were subsequently retrofitted with improved ducting systems. The retrofits resulted in an increase in average system efficiency of 16 percent.

Efficient Lighting Products

These papers describe various aspects of efficient lighting products. Galowin, Rossiter, Runkles, and Brown discuss laboratory accreditation methods for testing energy-efficient lighting products. Development of these accreditation methods should result in more reliable lamp test data in future years. Davis, Ji, and Luan describe the problem of "equivalence" when comparing incandescent and compact fluorescent lamps. Data for several different lamp types are presented to show that equivalent light output is generally not achieved. The use of compact fluorescent lamps in Mexico is described by Blanc and de Buen. Early small- and middle-scale programs are now leading to a large-scale CFL program, which will be implemented in **1994.**

Conclusion

Papers in this panel provide information regarding new technologies that can improve the performance of both new and existing buildings. The results and methodologies should help designers in evaluating and selecting these new technologies.

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